PWS-5

~~GROUND~~GROUND WATER UNDER THE DIRECT INFLUENCE OF SURFACE WATER (GWUDISW)

~~2002~~2008 EDITION

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SECTION 1.0 PURPOSE

The purpose of this Circular is to protect public health by classifying those ground water sources that have a potential to be directly influenced by surface water as defined by 40 CFR § 141.2 and to apply the surface water treatment requirements (40 CFR § 141.70~~) to those systems that are directly influenced by surface water.~~). The Ground Water Under the Direct Influence of Surface Water (GWUDISW) determination process will examine all public water supply systems (PWSs~~) and proposed water supply systems that have ground water sources reviewed under Department of Environmental Quality (DEQ) Circular, DEQ-3.~~).

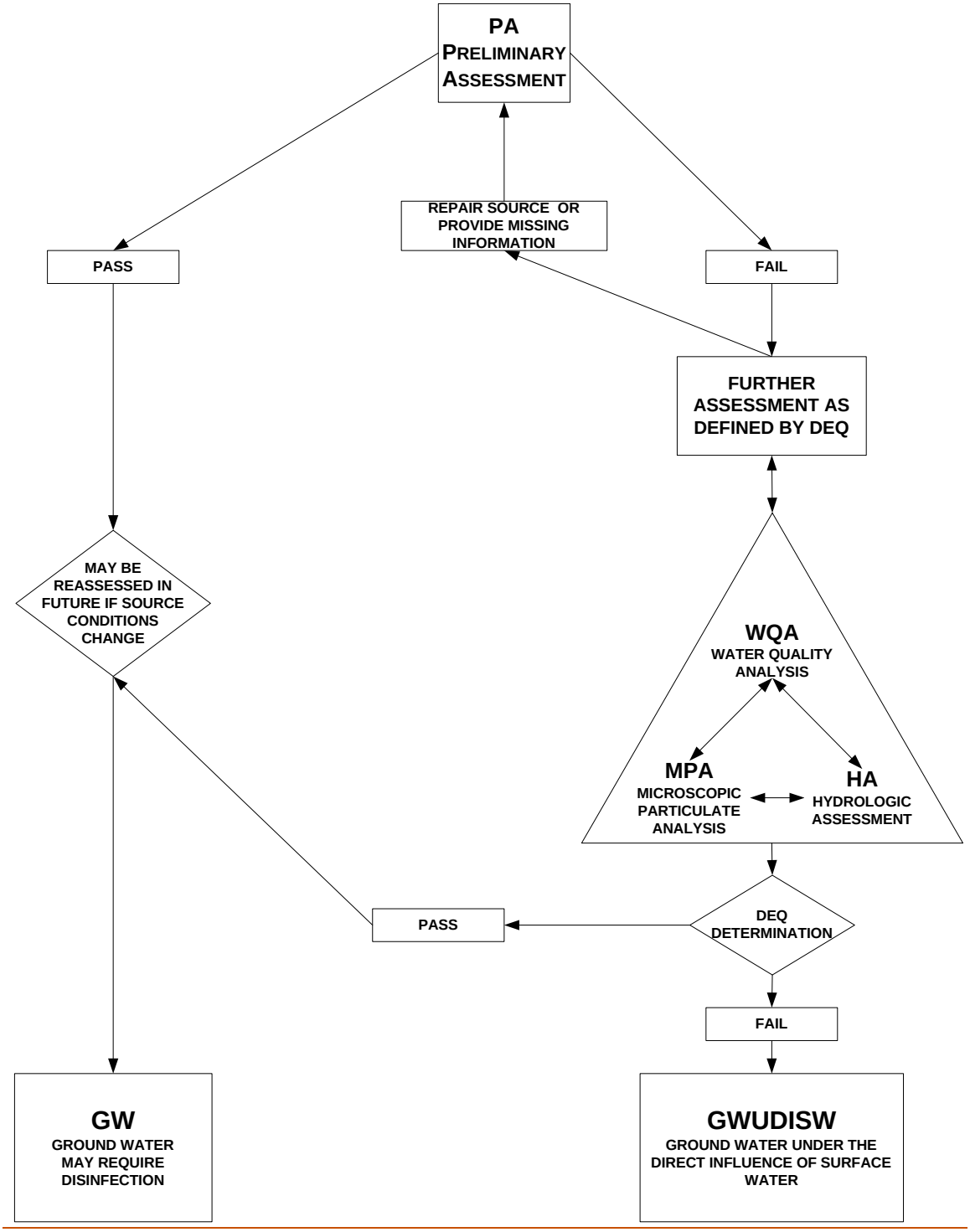
~~Under~~Using this process, ~~the~~ DEQ PWS Section~~, will evaluate~~ is responsible for evaluating existing ground water sources. Systems will be evaluated ~~in~~in this order; community PWSs first, ~~then~~ non-transient non-community PWSs second, and ~~finally~~ transient non-community PWSs last. The process will begin with a Preliminary Assessment (PA) conducted by DEQ personnel or contractors working for DEQ. Depending on the results of the PA~~-~~, the DEQ may determine the source not to be under the direct influence of surface water or the DEQ may require the following options: the source may be studied further; additional source information may be requested; or repair of source construction deficiencies ~~may be required. The options~~ (Figure 1). Options for further study include Hydrogeologic Assessment (HA), Water Quality Assessment (WQA), and Microscopic Particulate Analysis (MPA). DEQ has the discretion to require any or all of these options and to require further assessment after any construction deficiencies of a source are repaired. Proposed systems must pass ~~a number of~~ assessments specified by DEQ~~, and applicants~~. Applicants must submit the analytical results from ~~the~~any assessments(HA., WQA., or MPA) to the DEQ for review and approval. DEQ may conduct an independent investigation in addition to that required ~~by~~ of the applicant or PWS~~s~~.

SECTION 2.0 ~~SURFACE WATER~~ GWUDISW DEFINED

Ground water under the direct influence of surface water or GWUDISW means any water beneath the surface of the ground with significant occurrence of insects or other macroorganisms, algae, or large-diameter pathogens such as Giardia lamblia or Cryptosporidium, or significant and relatively rapid shifts in water characteristics such as turbidity, temperature, conductivity, or pH which closely correlate to climatological or surface water conditions (40 CFR § 141.2).

Throughout the GWUDISW process a key concept will be the definition of "surface water." Surface water is defined as any water that is open to the atmosphere and is subject to surface runoff (40 CFR § 141.2). This includes perennial streams, rivers, ponds, lakes, ditches, and some wetlands, as well as intermittent/ephemeral streams and natural or artificial surface impoundments that receive water from runoff.

Figure 1 (PWS - 5)



When intermittent/ephemeral streams are flowing, they may be important sources of recharge to the aquifer. Perennial streams are generally fed by ground water (i.e., base flow) throughout the year. ~~The~~ Streambeds of intermittent streams are above the water table throughout a portion of the year~~, flowing only~~ Streams begin to flow when ~~either~~ the water table rises to intersect the streambed~~,~~ or when rainfall occurs at a rate that exceeds infiltration ~~and as~~. As a consequence it runs off~~, directed~~ into the channels of the intermittent stream. Ephemeral streams only flow when rainfall occurs at a rate that exceeds infiltration. In ~~either case~~any of these cases, infiltration to the aquifer can occur through the streambed and banks.

~~Surface water classification will be decided by the DEQ on a case-by-case basis.~~

~~SECTION 2.1 GROUND WATER DEFINED~~

For purposes of the GWUDISW process, ground water is defined as a source of water that DEQ has not ~~been~~ determined ~~by the DEQ~~ to be surface water or ground water under the direct influence of surface water as defined in this Circular. Proper construction details for ground water sources are discussed in the DEQ Circulars DEQ-1 and DEQ-3. ~~Questionable sources that have been constructed without DEQ approval will be evaluated for direct influence of surface water in accordance with the provisions of this Circular.~~

Ground water sources may be influenced by surface water. Direct surface water influence is that influence that may cause the risk of pathogenic organism (*Giardia Lamblia, Cryptosporidium, viruses, bacteria*) transfer from a surface source to a ground water source. If the procedures outlined in this Circular indicate that the source is directly influenced by surface water, it will be subject to the Surface Water Treatment Rule (SWTR) requirements (40 CFR § 141.70), as discussed later in this Circular.

Due to the wide variety of ground water collection sources (wells, horizontal wells, infiltration galleries, spring boxes), it is difficult to physically define a ground water source. However, ground water sources generally have the following characteristics:

a. The initial intake location is below ground surface or below the bottom of ~~a~~ surface water; or

b. For springs that discharge at ground surface, a sealed spring box must properly isolate the source from surface influences; and

c. There is natural or engineered ~~soil/geologic~~earth material completely surrounding and protecting the initial source intake.

Any form of surface water diversion for use in a ground water system ~~may~~will cause that source to be classified as surface water that must meet all the applicable treatment regulations required of surface water sources under the SWTR, 40 CFR § 141.70, and Administrative Rules of Montana (ARM) 17.38.201, et seq.

SECTION 3.0 PRELIMINARY ASSESSMENT (PA)

The GWUDISW determination process begins with a Preliminary Assessment (PA). The DEQ, its contractors, or the applicant (for new proposed sources only) must complete a PA form for each existing or proposed ground water source that serves ~~PWSs, proposed water supply systems, and multi-family water supply systems reviewed under Circular DEQ-3.~~a PWS. A copy of the PA form and directions for completing the PA form for ground water sources are shown on Pages 5-8 of this Circular.

The PA uses a point system to evaluate the water sources based on the results of the PA (Figure 1). Sources that score less than 40 points ~~are~~ may be classified as ground water unless other information becomes available that suggests that further review is necessary. Sources that score higher than 40 points will require further analysis, source rehabilitation, or additional source information to complete the PA, at the discretion of the DEQ. Results of the PA are based on historical microbiological and pathogenic sampling, source construction details, and proximity of the ground water source to surface water. PWS operators and owners may be asked to provide well log records and other information as necessary to assist in completing the PA form.

MONTANA DEPARTMENT OF ENVIRONMENTAL QUALITY
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PRELIMINARY ASSESSMENT WORKSHEET

Preliminary Assessment of Ground Water Sources that may be Under the Direct Influence of Surface Water

SYSTEM NAME _____ PWS ID# _____

SOURCE NAME _____ COUNTY _____

DATE _____ NC NTNC C POPULATION _____

Index Points

A. TYPE OF STRUCTURE (Circle ONE that Applies)

~~Well ..... GO TO SECTION B~~
Spring 40
~~Infiltration Gallery/~~Horizontal Well ..... ~~4~~0

Well……..0

B. HISTORICAL PATHOGENIC ORGANISM CONTAMINATION

History or suspected outbreak of Giardia, or other pathogenic organisms associated with surface water~~,~~ with current system configuration 40
No history or suspected outbreak of Giardia or other pathogenic organisms 0

C. HISTORICAL MICROBIOLOGICAL CONTAMINATION

Record of acute (boil order or fecal positive sample) MCL violations of the Total Coliform Rule during the last 3 years (Circle ONE that Applies)

No violations 0
One violation 5
Two violations 10
Three violations 15

Record of non-acute (two coliform positive samples in one month) MCL violations of the Total Coliform Rule during the last 3 years (Circle ONE that Applies)

One violation or none 0
Two violations 5
Three violations..... 10

_____DEQ-verified complaints about turbidity

_____……5____

D. HYDROLOGICAL FEATURES

Horizontal distance between surface water and the source
greater than 250 feet 0
175 - 250 feet ..... ~~5~~10
100 - 174 feet ..... ~~10~~20
less than 100 feet ..... ~~15~~40

E. WELL ~~CONSTRUCTION~~ SEAL

Poorly constructed well (uncased, or annular space not sealed to depth of at least 18 feet below land surface),
or casing construction is unknown 15

F WELL INTAKE CONSTRUCTION

In wells tapping unconfined or semi-confined aquifers, with a depth below land surface to top
of perforated interval or screen greater than 100 feet 0
50 - 100 feet 5
25 - 49 feet 10
0 - 24 feet 15
unknown 15

~~F. WELL INTAKE CONSTRUCTION~~

G. STATIC WATER LEVEL

In wells tapping unconfined or semi-confined aquifers, depth to static water level below land surface greater than 100 feet 0
50 - 100 feet 5
~~0~~25 - 49 feet 10
~~unknown ..... 10~~

0-24 feet 15
Unknown 15

H. WELL CAP CONSTRUCTION

Poor sanitary seal, or seal without acceptable material~~, or unknown sanitary seal type~~ 15

TOTAL SCORE _____

~~H~~I. PRELIMINARY ASSESSMENT DETERMINATION (Circle ONE that Applies)

1. PASS: ~~Well~~Source is ~~classified as ground~~not under the direct influence of surface water.
2. FAIL: Well must undergo further GWUDISW analysis.

3. FAIL: Spring ~~or Infiltration Gallery;~~ must undergo further GWUDISW analysis.

4. FAIL: Well or horizontal well less than 100 feet from surface water.

5. FAIL: Well will PASS if well construction deficiencies (section E or F) are repaired.

~~5~~6. FAIL: Well may PASS if well construction details (section E ~~or F~~, For G) become available.

ANALYST _____

ANALYST AFFILIATION _____

COMMENTS: _____

_____

DIRECTIONS FOR COMPLETING PRELIMINARY ASSESSMENT OF GROUND WATER SOURCES THAT MAY BE UNDER THE DIRECT INFLUENCE OF SURFACE WATER

A. TYPE OF STRUCTURE

1. If the structure is classified as a Spring ~~or Infiltration Gallery, do not fill out sections B through G. Give~~, give a score of 40 and circle ~~option~~Option 3 in section ~~H~~I. Please continue with the rest of PA for further informational purposes of making a determination by the DEQ.

2. A well with collection laterals ~~is~~ may be classified as ~~an Infiltration Gallery.~~a Horizontal Well if it is within 100 feet of surface water. Give score of 40 and ~~circle option 3 in section H.~~continue with the PA.

B. HISTORICAL PATHOGENIC ORGANISM CONTAMINATION

Self-explanatory.

C. HISTORICAL MICROBIOLOGICAL CONTAMINATION

Base the acute and non-acute MCL violations on DEQ records for the three years preceding the date the PA form is being filled out. Acute violations typically are related to Boil Orders issued because of fecal or E-coli presence. Non-acute violations are typically health advisories issued because of at least two coliform positive samples in a one-month period, or failure to sample violations.

D. HYDROLOGICAL FEATURES

Use available information to determine nearest surface water. Surface water is defined as any water that is open to the atmosphere and ~~is~~ may be subject to surface runoff. This includes perennial streams, intermittent streams, rivers, ponds, lakes, ditches, some wetlands, and natural or artificial impoundments that receive water from surface runoff. In cases of doubt, the deciding factor will be whether the DEQ determines that the surface source may contribute surface organisms to the ground water source.

~~E. WELL CONSTRUCTION~~

If ~~well construction is unknown~~distance is less than 100' from surface water, score ~~30~~40 points and ~~go to~~ circle option 4 in section ~~F. However, if the data is available to answer at least one of the two questions in this section, do not score 30 points for "unknown well construction" and score the two questions in this section.~~ I. Continue with rest of form.

E. WELL SEAL

Self-Explanatory

F. WELL INTAKE CONSTRUCTION

~~If well intake construction is unknown, score 10 points and go to section G. However, if the data is available to answer at least one of the two questions in this section, do not score 10 points for "unknown intake construction" and score the two questions in this section.~~

Self-Explanatory

G. STATIC WATER LEVEL

Self-Explanatory

H. WELL CAP CONSTRUCTION

Is the top of the well properly sealed and vented to prevent contamination from entering the well? If not~~,~~ score 15 points.

Add up all the points accumulated in sections A through H and enter the sum here.

TOTAL SCORE _____

~~Add up all the points accumulated in sections A through G and enter the sum here.~~

~~H~~I. PRELIMINARY ASSESSMENT DETERMINATION

1.~~—~~ Well scored less than 40 points, and therefore ~~is~~ may be classified as ground water~~.~~

not under the direct influence of surface water 2.~~—~~ Well scored 40 points or more and could not mathematically score less than 40 points even if:

a. Information not available to answer questions in sections E ~~and/~~F, or ~~F~~G, becomes available and that information indicates the lowest point penalty should be applied; or

b. Well intake construction (~~section~~ sections E or F) deficiencies are repaired.

3. ~~Source automatically fails if it is a spring or infiltration gallery.~~ Source is a spring, further GWUDISW analysis.less than 100 feet from surface water.

4. Source is a well or horizontal well less than 100 horizontal feet from surface water.

5. Well scored 40 points or more, but ~~will~~ may score ~~under~~ less than 40 points if well intake construction deficiencies are repaired.

~~5~~6. Well scored 40 points or more, and could mathematically score under 40 points if unknown information in section E becomes available.

~~SECTION~~ **3.1 PRELIMINARY ASSESSMENT SCORE**

If a source scores 40 points or more on the PA and the score can be decreased to below 40 by supplying information not originally available for the PA (in most cases this will be a copy of the source well log or replacing the well cap with an approved model), the source ~~will~~may be classified as ground water. If the new information does not result in a PA re-score below 40 or the information is not made available, the source must undergo further assessment.

All existing and proposed springs ~~and infiltration galleries~~ will automatically score 40 points, at a minimum~~,~~ on the PA, and must undergo further assessment. Similarly, existing ground water wells and horizontal well sources will automatically fail the PA if they are less than 100 feet from surface water. These sources will require further assessment as shown in Figure 1. All other existing and proposed sources that score 40 or more points must also undergo further assessment. Spring sources with poor construction will have the option of re-constructing the spring box and be re-assessed by the DEQ, but will still score 40 points.

SECTION ~~3.2~~4.0 FURTHER ASSESSMENT

The DEQ must review and approve the evaluation methods a system uses to make the GWUDISW determination. The ~~Water Quality Assessment (WQA) and/or the~~ Hydrogeological Assessment (HA), the Water Quality Assessment (WQA), and the Microscopic Particulate Analysis (MPA) are the general methods used by systems for existing and proposed sources requiring further assessment.

The procedure for the WQA involves frequent and simultaneous measurements of water quality parameters ~~in~~that compare ground water ~~and~~ with nearby surface water to help determine if a hydraulic connection exists. A hydraulic connection is a subsurface pathway ~~through which water can~~ that allows water to travel ~~between~~from surface water ~~and~~to an aquifer. The HA uses both geologic~~al~~ and hydrologic information to determine if a possible hydraulic connection exists between ground water and surface water. ~~Microscopic particulate analysis (MPA)~~ The MPA (microscopic particulate analyses) analyzes the water source for organisms that are typically associated with surface waters. MPA sampling for surface water organisms ~~is~~ may be required ~~for sources that have a hydraulic connection to surface water. MPA sampling may be used as the first and final step in the evaluation process~~by the DEQ or in conjunction with the HA or WQA .

~~The data collected during the WQA and the HA is analyzed to determine if a ground water source is in hydraulic connection with surface water. If the WQA or HA results indicate a hydraulic connection, MPA testing will be necessary to determine if surface water organisms are present. A hydraulic connection alone, however, does not establish direct surface water influence. The DEQ will give~~

~~further guidance to applicants if a hydraulic connection is determined~~Figure 1 shows that the HA, WQA, and the MPA have equal weight in the GWUDISW evaluation process. At the discretion of the DEQ, any combination or all of these methods may be required. Similarly, the DEQ may require just a single method. DEQ will decide which method or methods are appropriate on a case-by-case basis. Based on the results of any method or a combination of methods (HA, WQA, MPA) a given source may be classified as GWUDISW.

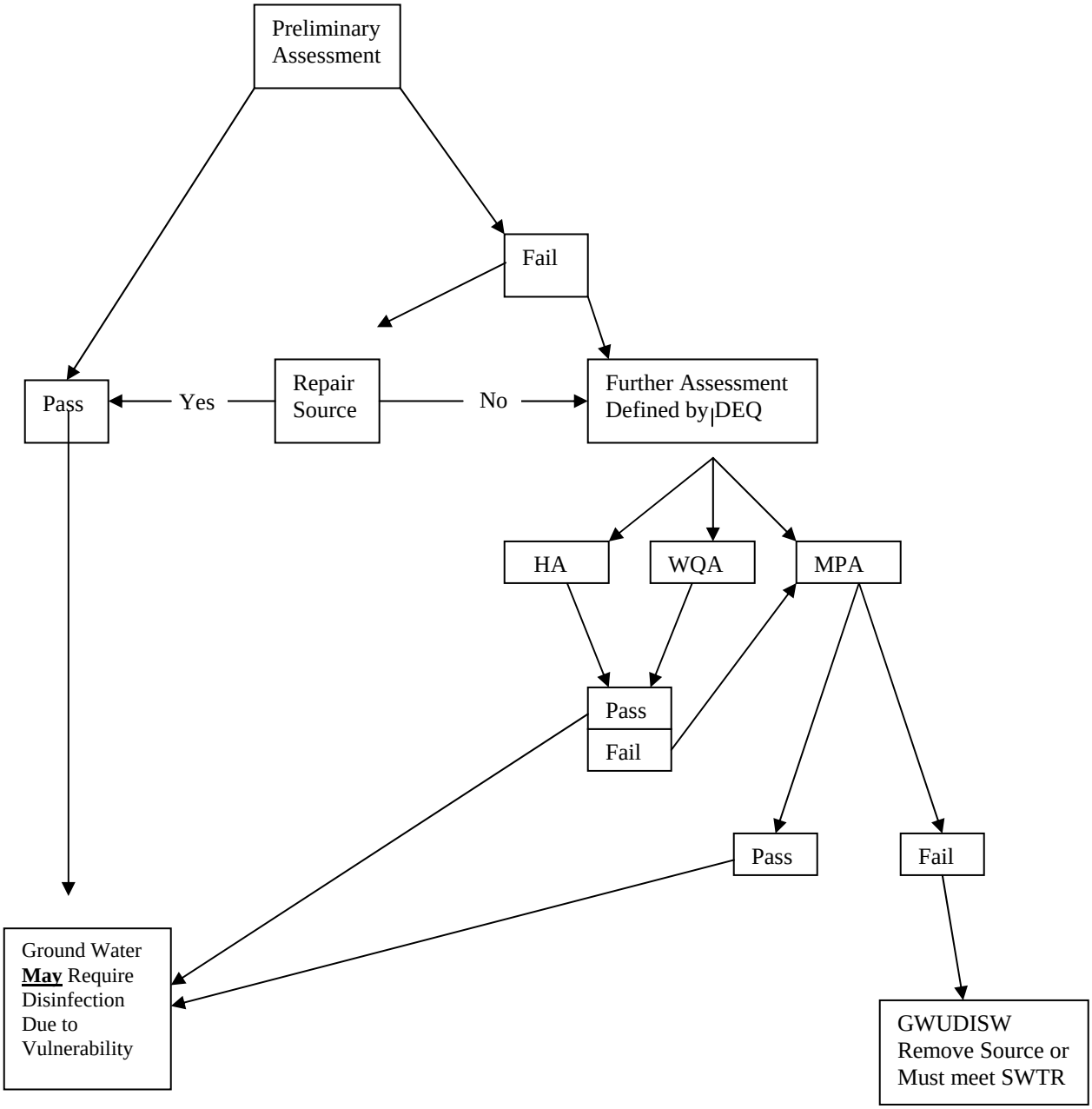
SECTION 3.3 SOURCE EVALUATION

If a source scores 40 points or more on the PA and the score can be decreased to below 40 by repairing source construction deficiencies noted in the PA, the source may be classified as ground water. (This assumes the owner will perform the repairs rather than risk being classified as GWUDISW if the determination process is allowed to continue beyond the PA).

Figure 1, on the following page, presents the options for those PWS sources with PA scores of 40 or higher when source rehabilitation or supplying additional source information cannot bring the PA score below 40. These options address two questions: First, does a hydraulic connection exist between the ground water source and surface water? If the answer to this first question is "yes," then, are there unacceptable numbers of surface water organisms present in the ground water?

A WQA or a HA is required in order to answer the first question. Sources such as infiltration galleries and springs are typically hydraulically connected to surface water; therefore, water suppliers may elect not to conduct either of these assessments. The main question for these sources is whether unacceptable numbers of surface water organisms are influencing the ground water. MPA sampling addresses this question and may be conducted as the first and final step for GWUDISW determination. Ground water wells are less prone to surface water influence than infiltration galleries and springs; therefore, for well sources, water suppliers also have the option of conducting a WQA or HA initially or bypassing those assessments and going directly to the MPA stage of the GWUDISW determination for well sources.

~~Figure 4.~~1 ~~– Source Evaluation~~



~~SECTION 3.4~~ PROPOSED GROUND WATER SOURCES

~~The suitability of new~~New ground water sources must also be addressed relative to the GWUDISW classification. The approach to classifying proposed sources may vary more than existing sources. The supplier proposing the source must submit to DEQ a PA as part of the Circular DEQ-1 or DEQ-3 submittal requirements. The information for the PA must be submitted with, or prior to, the submission of the plans and specifications for review. In all cases, the PA information must be provided before DEQ approval is granted. It may be in the best interest of the supplier to complete the PA prior to completion of the plans and specifications, as the PA results might influence the supplier's decision to pursue development of the source.

SECTION ~~4~~5.0 HYDROGEOLOGIC ASSESSMENT (HA)

If the ~~HA~~Hydrogeologic Assessment indicates that the aquifer supplying the source is not ~~in hydraulic connection with~~under the direct influence of surface water ~~(that is, a "negative" result for the assessment),~~ the source ~~is~~may be required to conduct further assessment (e.g., WQA, MPA) at the discretion of the DEQ or the source may be classified as ground water not under the direct influence of surface water. If the ~~HA~~Hydrogeologic Assessment indicates the potential for hydraulic connection ~~(that is, a "positive" result),~~ the system must be further analyzed for surface water organisms ~~by~~via MPA and/or WQA testing. Hydrogeologic factors (such as those listed below) are examined under this assessment. Any system proposing to conduct a HA must submit a plan of action to the DEQ for review and approval prior to conducting the HA.

~~SECTION 4~~5.1 EVALUATION OF THE HYDROGEOLOGIC ASSESSMENT

a. Regional Geology

~~1.Lithologies of hydrostratigraphic units (aquifers)~~

1. Lithology of Stratigraphic units (e.g., saturated units – aquifers, and non saturated units)
2. Lateral extent of units
3. Thickness of units
4. ~~Vertical~~Stratigraphy (e.g., vertical succession of units)
5. Structural trends (fractures, faults, folds, etc.) affecting permeability of, or
6. Hydraulic connection between units
7. Local topography

b. Regional Ground Water Flow System (Deep System)

1. Configuration of flow system (potentiometric map)
2. Horizontal and vertical flow directions
3. Hydraulic conductivity or transmissivity
4. Proximity of surface water bodies to regional flow system
5. Hydraulic connection among regional, intermediate and local flow systems

c. Intermediate Ground Water Flow System (Intermediate Depth)

1. Configuration of flow system (potentiometric map)
2. Horizontal and vertical flow directions
3 Hydraulic conductivity or transmissivity
4. Proximity of surface water bodies to intermediate flow system

d. Local Ground Water Flow System (Shallow)

1. Vadose zone characteristics
   - A. Soil type
   - B. Thickness
   - C. Moisture content
   - D. Unsaturated hydraulic conductivity
2. Configuration of flow system (potentiometric map)
3. Horizontal and vertical flow directions
4. Hydraulic conductivity or transmissivity
5. Proximity of surface water bodies to the local flow system

e. Surface Water Body (SWB)

1. Seasonal head (or stage)
2. Relationship between SWB head (or stage) and local and regional water table elevations (i.e. stream or irrigation canal)
3. Flow direction
4. Bed load or canal bed material
5. Channel or canal morphology

f. PWS Well Construction

1. Depth
2. Perforated interval

3. Interval of sand or gravel pack
4. Grout type and grouted interval
5. Condition of casing and cap
6. Land use in vicinity of well
7. Surface runoff flow patterns in vicinity of well
8. Lithologic log
9. Well diameter

g. PWS Pumping Well

1. Pumping discharge and duration of cycling periods
2. Pump characteristics
3. Configuration of steady state capture zone (zone of influence)
4. Intersection with SWB
5. Time of travel (TOT) between SWB and pumping well
6. Well interference affect on zone of influence
7. Distance between well and SWB

~~SECTION 4~~5.2 RESOURCES USED IN ASSESSMENTS

1. Geologic maps
2. Well logs
3. Ground water and surface water reports (MBMG, USFS and USGS)
4. Soil Conservation Service (SCS) soil maps
5. Seismic surveys
6. Site inspections
7. Physical and chemical analysis of water parameters

~~The WQA is more rigorous than the HA. If the WQA is negative (a hydraulic connection is not found), the source is declared ground water. This will happen even if the HA had "indicated" an apparent~~SECTION 6.0 WATER QUALITY ASSESSMENT (WQA)

In water quality assessments, water quality parameters are measured and compared between a ground water source and nearby surface water. The DEQ may decide if WQA testing is appropriate for a given site. If a WQA indicates that there is no hydraulic connection, the source may be classified as ground water not under the influence of surface water or the DEQ may require a MPA

test of the source water to corroborate results of the WQA. If the WQA indicates a hydraulic connection~~. If the WQA is positive (indicates a hydraulic connection)~~, the source must undergo MPA testing or be classified as ~~surface water. The results of the MPA will, in most cases, dictate the final classification of the source.~~GUDISW. Refer to Section ~~6~~7 .0 on MPA testing for a discussion of the results and classification process.

~~SECTION 5.0 WATER QUALITY ASSESSMENT (WQA)~~

In general, ground water quality exhibits only minor variations in chemical and physical ~~parameters.~~characteristics over time. Surface water ~~tends to experience more substantial variations as a function of season, rainfall and snowmelt events.~~ quality displays significant fluctuations because of complex interactions with ground water, temperature fluctuations, precipitation events, evapo-transpiration, If ground water is connected to surface water, ~~the~~ ground water quality characteristics should vary in general accordance with those of surface water ~~quality~~. There may be a time lag, but a consistent pattern of influence ~~will be reflected~~is usually evident over time.

The procedure for conducting the WQA involves frequent and simultaneous measurement of water quality parameters in ground water and nearby surface water. Taking and recording these measurements is the responsibility of the PWS for existing sources, or the applicant for proposed sources. Because of travel time between surface water and the ground water source, the variations in these two water sources will not necessarily occur at the same time. However, frequent measurements over a maximum period of one year should establish similar variation patterns if the two are in hydraulic connection. Any system considering a WQA must submit plans to the DEQ for review and approval prior to starting the process.

~~SECTION 5~~6.1 ~~WQA~~WATER QUALITY ASSESSMENTS FOR EVALUATION OF HYDROGEOLOGIC, CONNECTON UNDER THE GWUDISW DETERMINATION PROCESS

Background~~.~~

The variation in water quality parameters (~~i.e.~~ temperature, turbidity, conductivity and pH) in ground water~~,~~ isolated from the nearby influence of surface water~~,~~ tends to be minimal ~~(i.e. old ground water is generally very stable).~~ . The ~~actual~~ variation ~~exhibited~~ generally decreases with ~~the~~ increasing depth of ~~the~~ ground water. With respect to temperature for example, ground water that is at a depth of 25 to 50 feet may show a variation of several degrees centigrade throughout the year. Ground water at a depth greater than 100 feet may vary on the order of one degree centigrade over the same period. Surface water typically has considerably greater temperature variation because the water is in contact with the atmosphere.

In addition, isolated ground water undergoes only small variations in water quality parameters such as pH, and dissolved constituents (i.e. total dissolved solids, calcium, chloride, sulfate, etc.). ~~Because of differing levels of runoff versus inflow from ground water, or because of differing levels of biological activity, surface water may undergo significant variations in these parameters~~Surface water may undergo significant variations in these parameters

because of differing levels of runoff versus inflow to ground water, or because of differing levels of biological activity.

Ground water that is in hydraulic connection with surface water will show greater variations in water quality parameters than isolated ground water. Furthermore, variations in hydraulically connected ground water are often correlated to variations in ~~the~~nearby surface water ~~source~~. Because of chemical reactions in the subsurface and a time lag due to travel from the surface water to the aquifer, the influenced ground water will not show ~~the~~ variations identical to those of the surface water, and ground water ~~variation will not~~ variations may not occur at exactly the same time. For example, if the temperature of the surface water increases, the temperature of influenced ground water may not reflect that change for several days to several weeks, and then the variation may be significantly less than that observed in the surface water.

To evaluate whether or not a particular ground water source in proximity to a surface water source is hydraulically connected to surface water, periodic monitoring of both the ground water and surface water must be conducted. The data for the two should be compared to see if variations that occur in surface water throughout the year are also seen in the ground water.

Requirements.

At a minimum, for the WQA, the PWS system or proposed source developer must make weekly measurements of temperature, turbidity, and conductivity or temperature, turbidity and pH from both the ground water source and the nearby surface water source. Other requirements may be required at the discretion of DEQ. These weekly measurements must be made over a period of one year; if data is conclusive in less than one year, the WQA can be terminated at that time. Data should be recorded by the PWS or proposed source developer and submitted to the DEQ using the form depicted in ~~the following Table (~~Table 1~~)~~, or any other spreadsheet having the same format. Dedicated data loggers that can monitor water quality at hourly or more frequent intervals are the most efficient method for conducting a WQA. Their use may allow the WQA to be completed more quickly than if weekly measurements are used.

Montana Department of Environmental Quality
Public Water Supply Program

Water Quality Assessment
Data Report Form for GWUDISW Determinations

System Name _____ Report Prepared By _____
Source Name/ID _____ Month/Year _____
PWSID No. _____

TABLE 1

Day	Weather Conditions/ Air Temp	Source Water Temp	Surface Water Temp	Source Water Turbidity	Surface Water Turbidity	Source Water pH	Surface Water pH	Source Water Conductivity	Surface Water Conductivity

Table 1 - Spread-sheet Example

The PWS or proposed source developer shall also submit graphs showing temperature variation (see Figures 1a and 1b), conductivity, and turbidity on the y-axis, and time on the x-axis. On each graph, the appropriate data for both the surface water and the ground water must be displayed. If there is more than one ground water source, separate sets of graphs for each source must be submitted.

In the example in Figure 1a, a ground water source is ~~portrayed~~shown that ~~is not in~~exhibits little (based on conductivity) or no (based on temperature) hydraulic connection with a surface water source. Ground water exhibits a small temperature variation that is not related to the significant variation that characterizes the surface water. The example in Figure 1b, however, reflects ground water in hydraulic connection~~. Note in both examples that the conductivity of the ground water varies in a similar fashion to the~~ with surface water~~ source.~~

Figure 1-a - No Hydraulic Connection

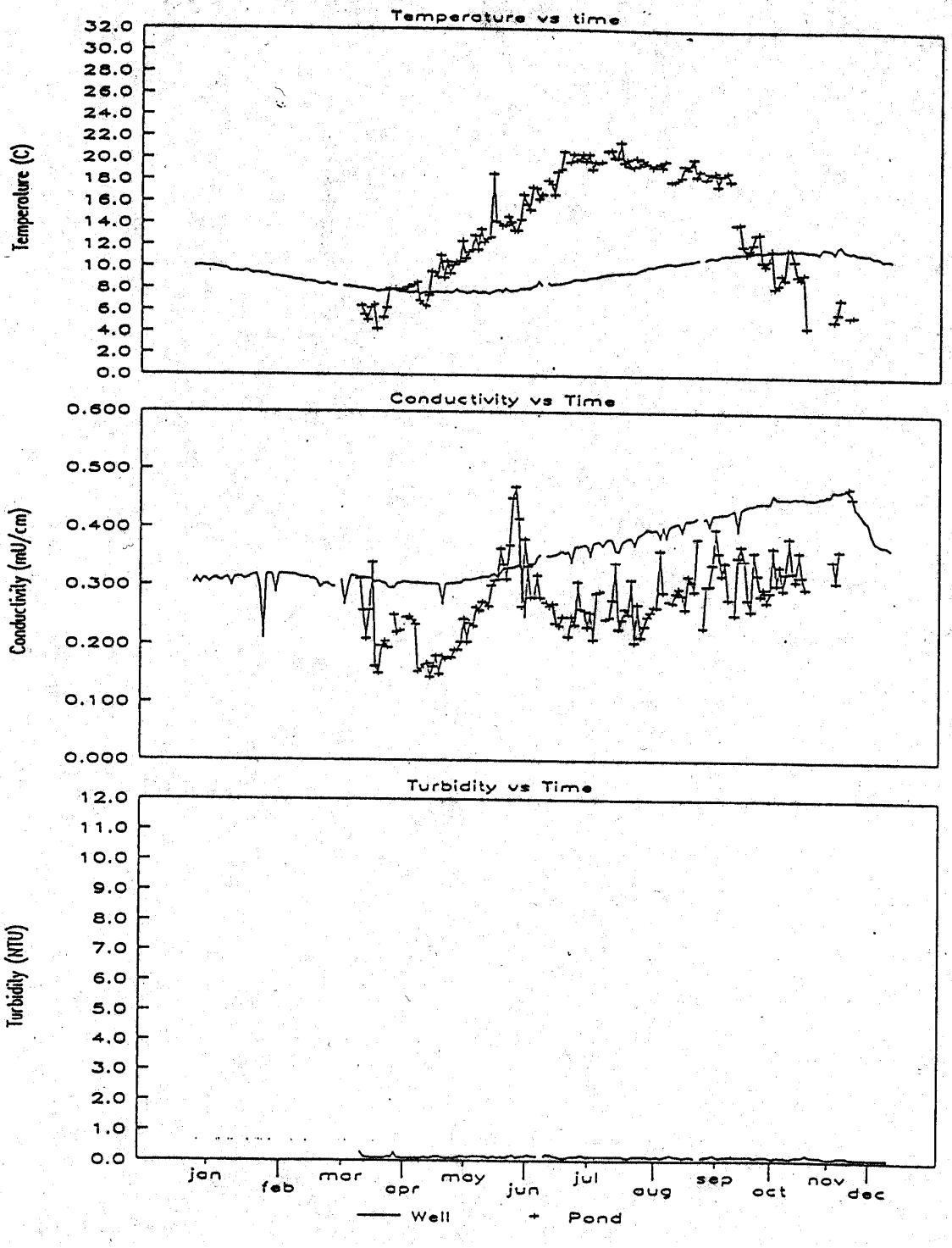
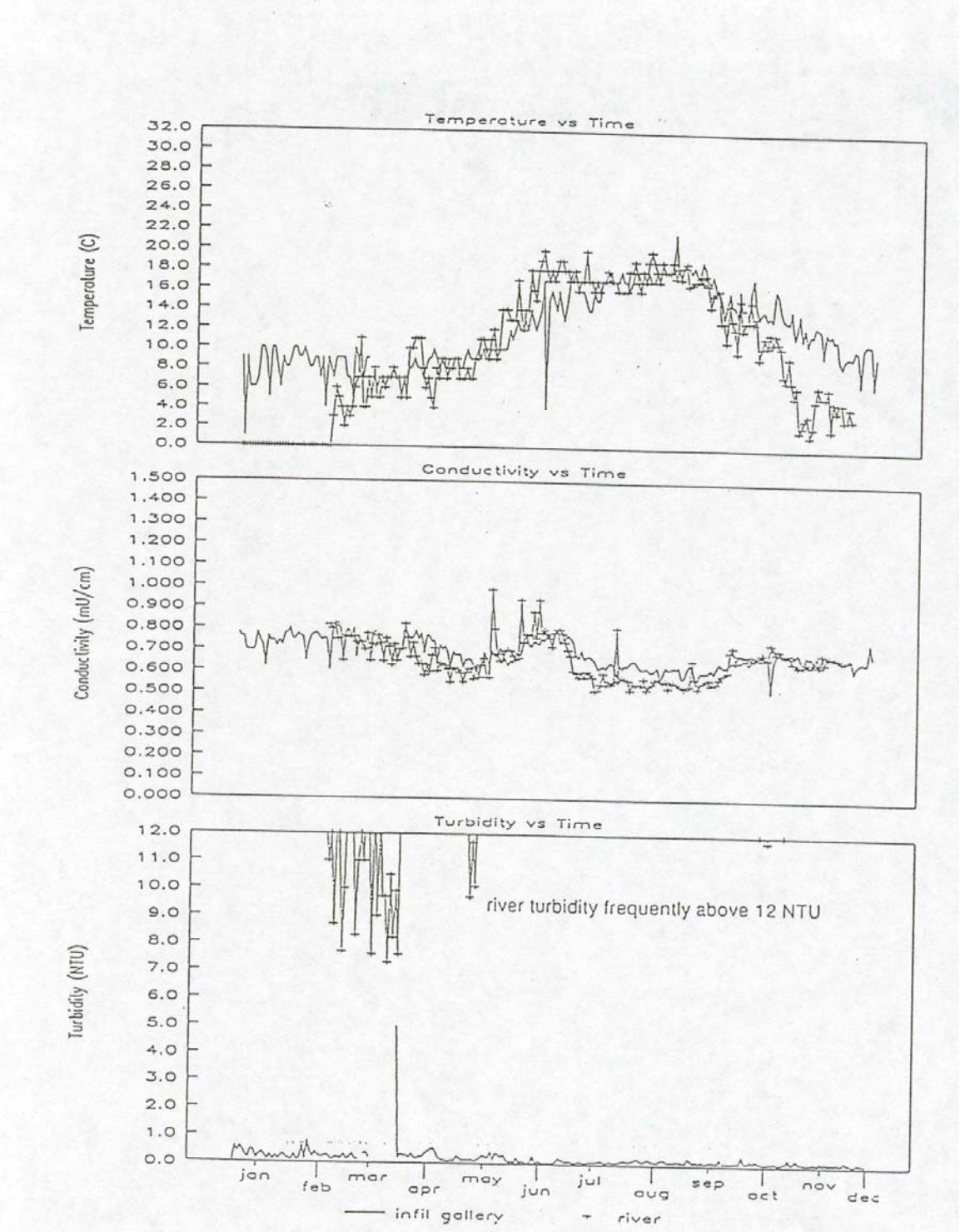


Figure 1-b - Probable Hydraulic Connection



Sampling Method.

For purposes of the GWUDISW determination process, ~~both the~~ water from the wells, infiltration galleries ~~and/~~or springs ~~in question~~ and the ~~potential~~nearby surface water source(s) must be ~~sampled/~~measured during the same ~~time~~ period. To adequately assess the potential of hydraulic connection, samples must be carefully and consistently collected. Samples collected from ~~the~~ ground water source and from a surface water source must represent water in the ~~water~~aquifer and the bulk volume ~~that is in or moving through the source.~~of the surface water, respectively.

Sample Site and Equipment.

When collecting WQA data it is important to collect surface water information that is representative of the bulk of the water that is in the lake, stream, or spring. A stream bottom is often irregular ~~in form~~, consisting of deep pools, the active channel, and shallows. A sample collected in the main portion of the channel is more likely to reflect the water that is infiltrating because it is more representative of the bulk of the water that is flowing through the stream or river. On the other hand, a sample from the shallows can potentially be quite different from the bulk of the water in the system due to more stagnant conditions or a higher level of biological activity. The same applies to a lake or pond. Therefore, samples need to be collected deep enough to be representative of the main water body.

Detailed studies of surface water quality generally involve more rigorous methods of sampling to more accurately represent the mass of water moving through the stream (i.e. several depth-integrated samples weighted to reflect the various masses of water each sample represents). For this study, however, only a single sample site is required, preferably in the mid-channel portion of the stream.

The mid-channel sample can be collected in the zone of analysis. The zone of analysis is delineated from a point on the stream with the shortest distance to the water source and extends one mile upstream and 0.25 miles downstream from that point. The analysis zone cannot have any other tributaries entering the stream within that distance. The sample may be collected from a bridge, dock, or boat. Because the data from the surface water source is compared with data from the ground water source(s), it is very important that once a sample site is selected, the same site and procedures are used each time. A topographic map showing the source location(s) and sampling sites should be submitted when the data is submitted.

Test equipment should be portable and suitable for field measurements. Temperature measurements should be collected using a digital thermometer capable of recording to the nearest tenth of a degree centigrade. Conductivity measurements should be collected using a digital conductivity meter capable of reporting to the nearest microsiemen (or micromho) per centimeter, over the range of 0 to 2000 S/cm, and preferably temperature compensated. Turbidity measurements should be collected using a turbidimeter capable of reporting to the nearest tenth of a ~~nephelometric~~Nephelometric Turbidity Unit (NTU).

For pH measurements, a digital pH meter capable of measuring pH to 0.1 pH units should be used.

Surface Water.

Surface water samples analyzed for temperature should be collected by bailing, using a ~~previously cleaned~~clean bucket with a minimum capacity of one gallon. The bucket should be rinsed a minimum of three times in the surface water source so that the temperature of the sample may be brought as near as possible to the temperature of the surface water. (Filling the bucket with the source water, letting it sit for several minutes, and then dumping and refilling should obtain a representative sample of the water). Sampling or bailing procedures should be accomplished without stirring up bottom sediments.

~~Each measurement event must continue until the results of three successive bailings agree within 0.5 degrees centigrade. Similar procedures should be followed for conductivity and turbidity.~~Surface water measurement must be conducted consistently. Each water measurement should be collected at the same time each week. The measurement should be taken at a depth of approximately one foot or more.

Ground Water.

Routine weekly measurements of source water should occur ~~under flowing conditions.~~after purging the ground water source. If the well flow is off, it will be necessary to allow it to pump until the well bore is filled with water solely from the aquifer ~~(i.e. the well should be purged).~~. Normally this is accomplished after pumping an equivalent of three to five well volumes.

Calculation of the well volume is as follows:

Depth of Water in Well (Dw) = Depth of Well - SWL

where SWL = static water level, the level of water in the well, measured from the surface, when the well is at rest (i.e. the pump has been off for at least 12 hours)

Well Volume (in gallons) = Dw x πr^2 x 7.48

where π = 3.14 and r = radius of the well bore in feet. The time required to pump 3 well volumes is given by

Time (minutes) = 3 x well volume/pump rate (gpm)

Direct Surface Water Influence Determination.

Weekly monitoring of temperature, turbidity, specific conductivity, and pH is required up to twelve consecutive months on sources undergoing the WQA. These parameters must

be monitored on both the ground water and the nearby surface water source.

~~Surface water measurement must be conducted consistently. Each water measurement should be collected at the same time each day. The measurement should be taken at a depth of approximately one foot or more. Measurement of well water should occur after the well has been flowing long enough for the temperature to stabilize (normally 3 to 5 well volumes).~~

If the data from the ground water shows little or no correlation with data from the surface water ~~(i.e. a "negative" result)~~, then ~~there is not~~ a hydraulic connection is unlikely and the source ~~will~~may be classified as ground water not under the influence of surface water at the discretion of DEQ. If a correlation does appear between the data ~~(i.e. a "positive" result)~~ or the results are ambiguous, ~~a~~an MPA analyses will be required. ~~(See Section 5.0, et seq. on WQA for a discussion of the results and classification process).~~

SECTION ~~6~~7.0 MICROSCOPIC PARTICULATE ANALYSIS (MPA)

Microscopic Particulate Analysis (MPA) testing is used to determine if surface water organisms are present in ~~a~~ ground water sources. The Environmental Protection Agency (EPA) has published a detailed technical document on methods for using particulate analysis to establish direct surface water influence (EPA 910/9-92-029: Consensus Method for Determining Ground waters Under the Direct Influence of Surface Water Using Microscopic Particulate Analysis (MPA)). This document must be followed when conducting MPA tests. It states that because ground water under the direct influence of surface water is indicated by the significant occurrence of "...insects, algae, or other large-diameter pathogens," the MPA cannot be used as a presence-or-absence criterion. The document specifies a risk factor, which is based on the number of various bio-indicators (i.e. *Giardia Lamblia*, coccidia, diatoms, algae, insects/larvae, rotifers, and plant debris). Based on the risk factor associated with the results of each MPA, the source will receive a designation as a low, moderate, or high risk of surface water influence.

In completing the MPA, it is necessary for the PWSs to conduct between two and four analyses, as specified by the DEQ, per ground water source. This must occur over a 12 to 18 month period. The MPA must be performed during the periods of the year when surface water most likely influences ground water (i.e. spring and fall). For each MPA, the PWSs must collect the sample and send it to a qualified laboratory. The field sampling technique is outlined in Table 2 below; however, most laboratories provide a data sheet when they are contacted to provide MPA services. Sampling apparatus are available from the DEQ, and most laboratories that conduct microscopic work also rent sampling units.

MICROSCOPIC PARTICULATE ANALYSIS (MPA) SAMPLING DATA

SYSTEM NAME: _____ SAMPLE LOCATION: _____

SAMPLER: _____ SAMPLE ID (LAB USE): _____

DATE: _____

I. WATER DATA

WATER TYPE: _____ Finished _____ Raw

WATER SOURCE: _____ Spring _____ Infiltration Gallery _____ Other

_____River _____Pond _____Well

If Well, Type: _____Depth: _____ Distance from Surface Water Source: _____
(Dug, Drilled, Etc)

II. SAMPLING DATA

Start Time: _____ End Time: _____

Start Turbidity: _____ End Turbidity: _____

Start pH: _____ End pH: _____

Meter Reading Start: _____ Meter Reading End: _____

Start Flow (Manual): _____ End Flow (Manual): _____

Total Gallons Filtered: _____

III. NAME & ADDRESS OF PERSON TO RECEIVE REPORT:

_____

_____

_____

_____

Table 2 - Sampling Technique

The risk factor assigned to a ground water source is based on the MPA results. If the first two MPA results indicate the same risk factor, the source is considered to have that risk factor. If the first two MPA results do not indicate the same risk factor, additional MPA testing may be required by DEQ (up to a maximum total of four~~,~~ per source~~) will be required until consistent results are evident in at least two samples~~). If results of any MPA test indicate moderate or high risk then the source will be considered to be under the direct influence of surface water unless there are mitigating factors associated with well construction or other human activities.

Low Risk

Consistent MPA results of low risk ~~will~~may result in a classification of the source as ground water not under the influence of surface water. Although ~~a ground water~~this classification may be appropriate because of the lack of evidence for direct influence, other information may indicate (e.g., well construction details, WQA or HA data) the need for treatment of the ground water source. A source that has scored low risk on the MPA may also have shown a connection to surface water or other contamination sources via WQA, or historical information regarding bacteriological or chemical contamination of the water source. In these situations, the DEQ may still require additional treatment, such as full-time disinfection, to provide adequate treatment for the potential contamination.

Moderate~~-~~High Risk

~~Consistent MPA results of~~ A microscopic particulate analysis resulting in moderate or high risk will result in a GUDISW classification and an investigation of source construction. If it is found that the source construction could be causing surface water organisms to contaminate the ground water, then it will be necessary to determine if reconstruction or repair can occur~~. If~~ (Figure 1). Figure 1 indicates that if reconstruction or repair is possible, ~~the~~further assessment may be required by DEQ that may include another MPA evaluation ~~will be repeated~~ following ~~the~~repair or reconstruction. If reconstruction is not possible, the source ~~may~~will be classified as ~~ground water, with the recommendation of full-time disinfection or increased coliform monitoring. In addition,~~GUDISW, which will require that the source ~~will be required to provide approved surface water filtration if there are other indications that the source may be directly influenced by~~ meet all of the treatment requirements of a surface water ~~for all or part of the year.~~source as set forth in 40 CFR 141.70 Subpart H –Filtration and Disinfection, of the Code of Federal Regulations as adopted by reference in the Administrative Rule of Montana 17.38.208 Treatment Requirements

Evidence of surface water influence that would lead to mandatory full-time disinfection and/or approved surface water filtration includes, but is not limited to, evidence of flooding around the source; a lack of natural filtration between surface water and the source; and inability to adequately seal/protect the source from potential contamination sources.

~~*Those systems that choose or are required to disinfect must meet 4-log removal of viruses at a minimum.*~~

GW sources that are found to be susceptible under the new Ground Water Rule, effective October, 2009 will be required to provide a minimum of a 4-log virus inactivation.

Sources that are determined to be at risk for containing Giardia Lamblia*, are required to meet 3-log (99.9%) removal of* Giardia Lamblia *in accordance with ARM 17.38.208, 40 CFR § 141.70, and "Guidance Manual for Compliance with the Filtration and Disinfection Requirements for Public Water Systems using Surface Water Sources," EPA, 1991. The new "EPA UV Guidance Manual" is available to provide information for SW or GWUDISW sources that must provide additional inactivation of Cryptosporidium Cysts.*

~~*High Risk*~~

~~An MPA result of high risk will result in a classification of the source as GWUDISW.~~

In the unlikely occurrence that a source scores high-risk on only one MPA sample and has two other low- ~~or moderate~~ risk results, the DEQ may require additional testing as shown in Figure 1 to determine if the high-risk sample was an anomalous situation or indicates a definite health risk during specific atmospheric or hydrologic conditions that affect the water source. Additional testing will be required on a case-by-case basis but may, for example, consist of turbidity or particle counting for up to 12 months to determine the daily and seasonal water quality variation of the water source. Testing results are used to determine whether additional treatment is needed. All MPA testing should be scheduled with the laboratory performing the analysis prior to sample collection and shipping. The MPA sample collection protocol is defined below.

~~SECTION 6~~7.1 MPA SAMPLE COLLECTION INSTRUCTIONS

1. The sampling device should be connected to a sampling point as close to the source as possible.

2. Assemble the sampling apparatus and other equipment ~~as shown in Figure 1~~ without a filter in the filter housing. BE CERTAIN the sampler is assembled with the correct direction of the flow at the filter housing and the water meter, as indicated by the arrows on both devices.

3. Flush the equipment with water from the source to be filtered, without a filter in the housing. Flushing should continue for 3 minutes, minimum. Check all connections for leaks, repairing any leaks found. It is best to use an in-line, 1 gpm, flow restrictor to accomplish the desired rate.

4. Filtering should be conducted at a flow rate of approximately 1 gpm. During the flushing stage, the flow rate can be checked with a stopwatch and graduated bucket.

5. Shut off flow to the sampler. Wash hands or put on gloves. Install the filter in the housing. Make sure a rubber washer or o-ring is in place between filter housing bowl and base.

6. Using a water-resistant marking pen record the start time, meter reading, pressure, flow, (turbidity and pH if available~~))~~, on the MPA data sheet.

7. Turn water on slowly to the sampler with the unit in an upright position. Invert unit to make sure all the air within the housing has been expelled. When the housing is full of water, return unit to upright position and turn flow on completely.

8. Filtering should be conducted at a pressure of 10 psi. If the pressure is not 10 psi, adjust the pressure regulator.

9. Allow the sampler to run until 1,000 to 1,500 gallons have been filtered. Turn off the flow to the sampler. On the data sheet record the meter reading and the time that filtering was stopped.

10. Disconnect the filter housing and pour the water from the housing into a ziploc plastic bag. Carefully remove the filter from the housing and place it in the bag with the water. Seal this bag, trying to evacuate all air, and place it in a second ziploc bag. Make sure that neither bag leaks.

Pack the filter in a small, insulated container or ice chest with a bag of ice and/or blue ice packs taking care that the filter is not in contact with the ice or the filter may freeze. Frozen filter fibers cannot be analyzed. Transport the filter (and data sheet) to the laboratory so that it is received at the laboratory within 48 hours. ~~A supplier with a source designated as GWUDISW must comply with all applicable PWS requirements pursuant to ARM, 17.38.201, et seq.~~

GLOSSARY

Coccidia - A subclass of intracellular parasites that occur primarily in vertebrates.

Cryptosporidium - A single-celled, protozoan parasite that occurs primarily in vertebrates.

Diatoms - The most resistant group of algae; they are able to withstand a large amount of chemical, mechanical, and environmental insult.

Other algae - A large number of chlorophyll containing filamentous colonial and unicellular divisions of algae; they require sunlight for their metabolism.

Giardia Lamblia - A flagellated protozoan that colonizes the upper small intestine of many warm-blooded animals.

GWUDI/GWUDISW - Ground water under the direct influence of surface water. Any water beneath the surface of the ground with significant occurrence of insects or other macroorganisms, algae, or large-diameter pathogens such as *Giardia Lamblia* or *Cryptosporidium*, or ground water that shows rapid and significant shifts in water characteristics such as turbidity, temperature, conductivity, or pH which closely correlate to climatological or surface water conditions.

Insects/Larvae - Insects, insect parts, larvae, eggs and another group of Arthropods, the Arachnids.

Plant Debris - The undigested fecal detritus from herbivorous animals, usually muskrat and beaver.

Rotifers - A major taxonomic group; there are over 2500 species, of which greater than 2375 species are restricted to fresh waters. They are associated with a variety of habitats including small puddles, damp soils, vegetable debris, and mosses.

Specific Conductivity - A rapid method of estimating the dissolved-solids content of a water supply. The measurement indicates the capacity of a sample of water to carry an electrical current, which is related to the concentration of ionized substances in the water.

Surface Water - Any water that is open to the atmosphere and is subject to surface runoff. This includes perennial streams, rivers, ponds, lakes, ditches, and some wetlands, as well as intermittent streams and natural or artificial surface impoundments that receive water from runoff. If there is a question whether or not a particular body of water will be considered surface water in the context of the GWUDISW process, the deciding factor is: whether channelized drainage contributes water to the body. If the answer is "yes," the body is surface water.

TOT - Time of travel; the amount of time needed for a contaminant to travel to the intake of a source.

Turbidity - The cloudy appearance of water caused by the presence of suspended and colloidal matter. Technically, an optical property of the water based on the amount of light reflected by suspended particles. Turbidity cannot be directly equated to suspended solids because white particles reflect more light than dark-colored particles, and many small particles will reflect more light than an equivalent mass of larger particles.